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STORAGE FOR MUNICIPAL AND INDUSTRIAL WATER SUPPLY AND WATER QUALITY CONTROL EL DORADO, DOUGLASS, AND TOWANDA RESERVOIRS WALNUT RIVER BASIN KANSAS

Public Health Service
Dallas, Texas

April 1963

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KANSAS

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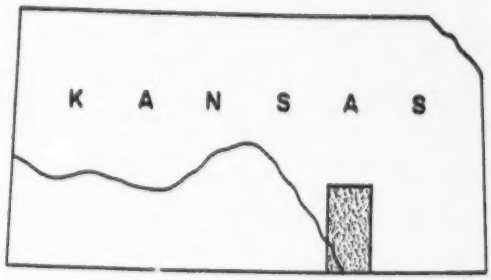

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

In Cooperation with the

DEPARTMENT OF THE ARMY
U.S. Army Engineer District - Tulsa, Oklahoma

APRIL 1963

3-3

STORAGE FOR
MUNICIPAL AND INDUSTRIAL WATER SUPPLY
AND
WATER QUALITY CONTROL
EL DORADO, DOUGLASS, AND TOWANDA RESERVOIRS
WALNUT RIVER BASIN
KANSAS

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Division of Water Supply and Pollution Control
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I. INTRODUCTION

Authority and Request

In a letter dated September 27, 1960, the Corps of Engineers, Tulsa District, requested the Public Health Service to study the water supply storage feasibility of the proposed El Dorado and Towanda Reservoirs, ". . . with particular emphasis given to determining the present and prospective water supply and pollution abatement needs; the quality of the water; the economic value of such water supply." This report was subsequently expanded to include the proposed Douglass project and to cover a 100-year future period as well as the needs for storage of water for quality control purposes.

This study has been made in accordance with: (1) the Water Supply Act of 1958 (Public Law 85-500, Title III) and a Memorandum of Agreement between the Department of the Army and the Department of Health, Education, and Welfare, dated November 4, 1958; and (2) the Federal Water Pollution Control Act (Public Law 84-660) as amended by Public Law 87-88.

Purpose and Scope

This report presents the results of an investigation to determine water requirements to the years 2020 and 2070 for municipal, industrial, and water quality control purposes in the Walnut River basin and how these needs may be met. An estimate of the average annual benefits which could be ascribed to storage allocated to these purposes is evolved from projected economic developments and anticipated needs for water supply and stream quality preservation.

Acknowledgments

The assistance and cooperation of agencies and individuals who aided in the assembly of data for this report are gratefully acknowledged. Special thanks are extended to the Kansas Water Resources Board, Kansas State Board of Health, and city officials and members of Chambers of Commerce of El Dorado, Augusta, Winfield, and Wichita, Kansas, as well as those representatives of industry in the Walnut River basin who supplied information relating to existing and expected water requirements.

II. SUMMARY AND CONCLUSIONS

Summary

1. This report describes the need for water for municipal, industrial, and quality control purposes which could be supplied from three reservoirs to be located in the Walnut River basin of the eastern part of south-central Kansas (see figure III-1). These reservoirs are El Dorado on Walnut River, Douglass on Little Walnut Creek, and Towanda on Whitewater River.

2. Water to be impounded at the El Dorado site is of high quality, i.e., low in mineral solids and suitable for general municipal and industrial use. While water to be stored at the Douglass site may be slightly inferior to that stored at the El Dorado site, its quality will be suitable for municipal and industrial purposes.

3. The study area consists of Butler and Cowley Counties, encompassing all but a very small headwater section of the Walnut River basin.

Conclusions

1. Population of the study area to be served by municipal water systems is expected to reach 115,000 by the year 2020. Total projected municipal water needed to serve that population is 20 million gallons per day (mgd) by 2020 (22,400 acre-feet).

2. Indications are that, although present water quality at the Towanda site is unsuitable for general municipal and industrial use with respect to chlorides, sulfates, and total dissolved solids content, future control of natural and oilfield brine pollution may restore satisfactory water quality in Whitewater River.

3. Industrial water requirements will increase principally as a result of use in petroleum refining, petrochemical production, and other industrial activities expected to locate in the study area. Total industrial water needed for the year 2020 is estimated to be 55 mgd (61,500 acre-feet).

4. Efficient utilization of the water resources of the Walnut River basin for municipal, industrial, agricultural, and other legitimate uses depends upon provision and maintenance of suitable water quality. Storage and release requirements for water quality control are critical in the upper basin. Expectations are that current needs in the Walnut River downstream from El Dorado could be met by storage at the proposed El Dorado site.

   Utilization of storage in the proposed Towanda project for quality control purposes by flow regulation will make water of suitable quality available for various legitimate uses, including water-oriented recreation and propagation of fish and aquatic life, in the middle and lower reaches of the basin, coupled with municipal and industrial water supply in the lower basin.

5. A plan for serving projected 2020 needs for municipal, industrial, supplemental irrigation, and water quality control purposes is summarized below.

	Requirement			Yield	
Use	Acre-ft. Annually	Avg. mgd	Source	Acre-ft. Annually	Avg. mgd
Municipal	22,400	20	Existing Impoundments	2,800	2.5
			Ground Water	10,000	9.0
Industrial	61,500	55	Proposed Projects		
			M & I Storage	35,100	31.4
			Quality Control Storage	16,400	14.6
Supplemental Irrigation	5,000	4.5	Future Impoundments	11,200	10.0
Water Quality Control	16,400	14.6	Lower Walnut River	31,000	27.5
TOTAL	105,300	94.1		106,500	95.0

6. Based on the proposed water supply plan, annual benefits of storage for municipal, industrial, and quality control purposes in the proposed projects, summarized below, are equal to the most reasonable alternative costs of providing water of equivalent quantity and quality at the locations within the Walnut River basin where needs are anticipated. The most reasonable alternative for each project is a single-purpose project within the watershed affected by the proposed projects.

Summary of Benefits - Proposed Walnut River Basin Projects

Proposed Site	Yield From Storage: Acre-ft. Annually	Yield From Storage: Avg. mgd	Purpose of Storage	Year of First Need	1970 Worth Average Annual Benefit ($1,000)
El Dorado*	12,300	11.0	Municipal and Industrial	1970	374.0
	5,800	5.2	Quality Control	1970	144.6
Douglass	15,900	14.2	Municipal and Industrial	1970	341.8
Towanda	2,200	2.0	Municipal and Industrial	2010	21.5**
	16,400	14.6	Quality Control	1970	330.1

*Initially El Dorado Reservoir should yield the amounts shown for quality control and municipal and industrial use. The 2020 plan would require that adequately treated wastes from upper basin be released downstream from the Whitewater River. Municipal and industrial use would be 17,000 acre-feet per year (15.2 mgd) with an average annual benefit of $518,600 for this use.

**1970 value discounted from 2010 at 2 7/8 percent.

III. DESCRIPTION OF PROJECTS

The three proposed Corps of Engineers projects in the Walnut River basin will be situated as shown in figure III-1. Pertinent data are illustrated in table III-1.

Table III-1

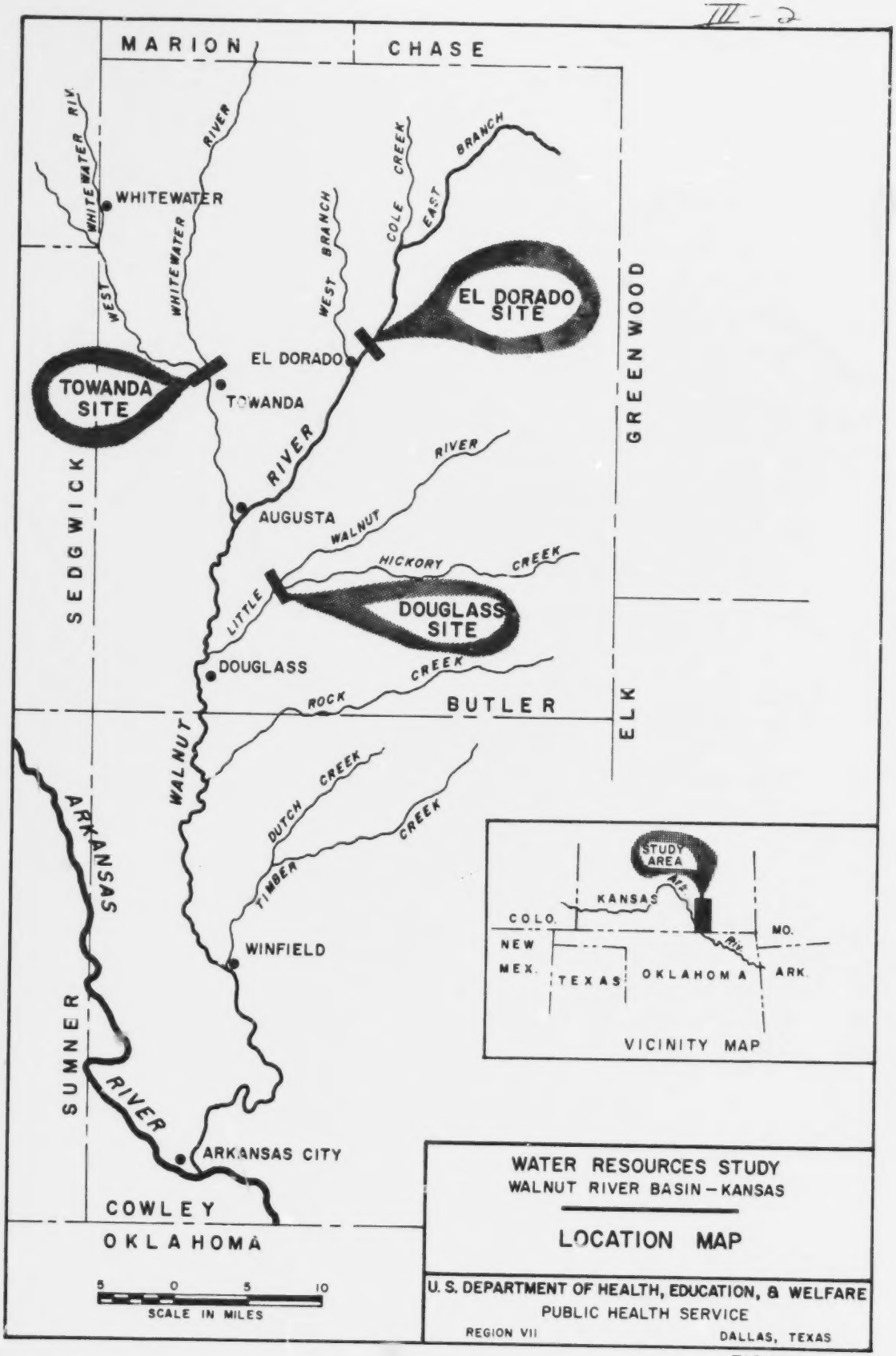
Pertinent Data[1/] - Proposed Reservoirs
Walnut River Basin

Reservoir	Stream	Location* (River Mile)	Drainage Area (Sq.Mi.)	Yield From Storage		Drought Recurrence Interval (Years)
				Acre-ft. Annually	Avg. mgd	
El Dorado	Walnut River	97.7	235	17,000	15.2	50
				21,000	18.8	20
Towanda	Whitewater River	18.5	422	11,800	10.6	50
				20,100	17.8	20
Douglass	Little Walnut Creek	6.7	238	15,900	14.2	50

*Distance measured upstream from mouth.

Streamflow

The greater part of the flow of Walnut River and its tributaries is surface runoff, with little contribution from ground water. A gaging station is maintained by the Geological Survey at Winfield (river mile 24.3). Discharge records from 1921 through 1961 are available for this station. [2-13/] Figure III-2, a discharge frequency curve, was constructed using these data. Based upon flow conditions reflected by that curve and available flow data, mean annual flows and modal monthly discharges from uncontrolled drainage area with proposed projects in place for this station at 80, 90, and 95 percent exceedence frequencies are as shown in table III-2.

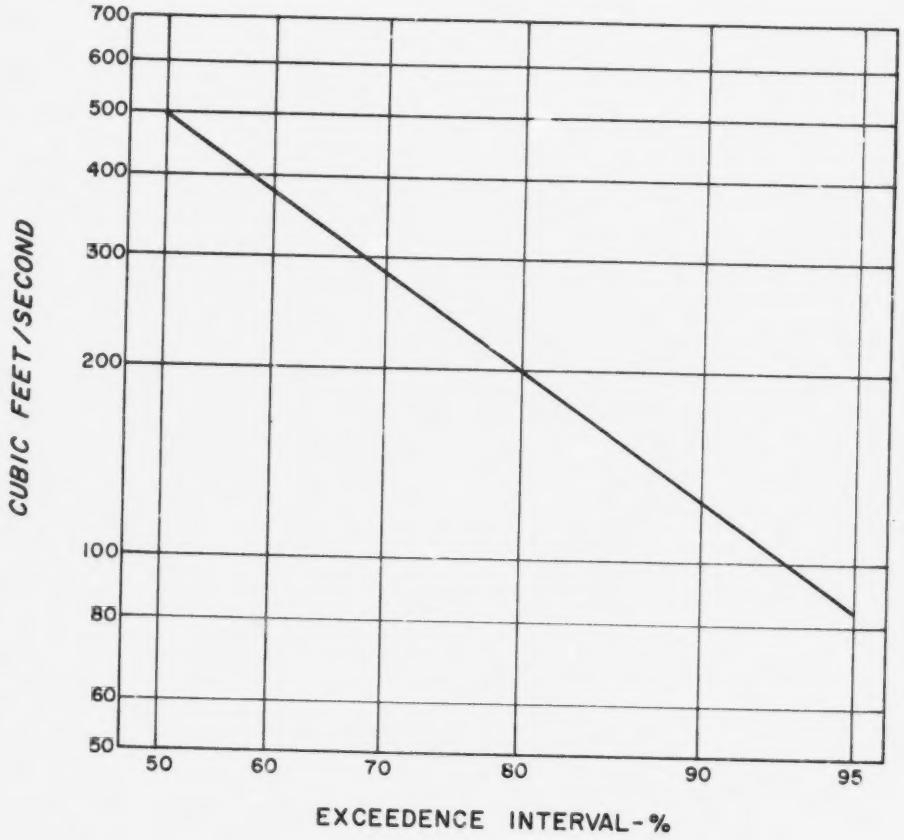


WATER RESOURCES STUDY
WALNUT RIVER BASIN – KANSAS

LOCATION MAP

U. S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE III – 1



WATER RESOURCES STUDY
WALNUT RIVER BASIN—KANSAS

ANNUAL DISCHARGE FREQUENCY
WALNUT RIVER AT WINFIELD, KANSAS

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE III-2

Table III-2

Monthly Distribution of Annual Discharge
Walnut River at Winfield, Kansas
(With Proposed Projects in Place)

Month	Percent of Annual Discharge	Mean Monthly Discharge at Various Exceedence Frequency Percentages					
		95%		90%		80%	
		Acre-ft.	Avg. mgd	Acre-ft.	Avg. mgd	Acre-ft.	Avg. mgd
Jan.	3.6	880	9	1,320	14	2,060	22
Feb.	3.8	930	11	1,400	16	2,170	25
Mar.	7.0	1,710	18	2,570	27	4,000	42
Apr.	14.8	3,610	39	5,430	59	8,470	92
May	21.7	5,300	56	7,960	84	12,410	131
June	20.6	5,030	55	7,560	82	11,780	128
July	9.8	2,390	25	3,600	38	5,610	59
Aug.	3.5	850	9	1,290	14	2,000	21
Sept.	4.3	1,050	11	1,580	17	2,460	27
Oct.	3.9	950	10	1,430	15	2,230	24
Nov.	3.7	900	10	1,360	15	2,120	23
Dec.	3.3	810	9	1,210	13	1,890	20
Annual Discharge		24,400		36,700		57,200	
		(34 cfs)		(51 cfs)		(79 cfs)	

Water Quality

Only a limited amount of water quality data is available for the reaches of the streams adjoining the proposed project sites. 14/ Oilfield brines are released to the streams in the area. These releases have rendered water in most of the basin streams unsuitable for general municipal and industrial use by increasing the dissolved solids and chlorides concentration beyond the limits set in the Public Health Service Drinking Water Standards. 15/ However,

abatement of this pollution is being undertaken by State authorities. The quality of the Whitewater River has improved markedly in the past several years, although not sufficiently to meet current municipal and industrial quality requirements for general use with respect to total solids, sulfates, and chlorides. Nevertheless, expectations are that a suitable blend of releases from these projects will be of satisfactory quality for general water supply use.

This is illustrated by results of analyses of samples taken from the Walnut River at Winfield in the period preceding oilfield operations in this basin (see table III-3). Indications are that this quality may be nearly equaled as the result of pollution control activities. Flow regulation through use of storage in the proposed projects should assure more consistent water quality in the major portion of the basin.

Table III-3

Results of Chemical Analyses [16]
Walnut River at Winfield, Kansas
(in parts per million)

Date	TDS	SO_4 =	Cl^-
8-22-07	361	73	17
9- 2-07	340	91	18
9-15-07	445	144	20
9-28-07	382	137	17
10-10-07	408	115	16
10-23-07	364	114	21
11- 5-07	478	141	29
11-16-07	539	175	23
11-26-07	---	----	15
9-26-12	241	47.6	20
7-28-13	356	100	13
1-13-15	280	57	22
8-25-15	386	80	12

IV. DESCRIPTION OF STUDY AREA

The Walnut River basin is located in the eastern part of south-central Kansas. The study area (shown in figure III-1), consisting of Butler and Cowley Counties, is situated in the Bluestem (Limestone-Flint Hills) region of Kansas. The terrain is rolling to hilly with steep breaks and escarpments adjacent to stream valleys. Grades of streams in the region are as much as 20 feet per mile. 17/

The mean temperature of the study area ranges from 32°F in January to 81°F in July for an annual mean of 58°F. Mean annual rainfall is about 32 inches with about 23 inches falling during the six-month period April through September. 17/

El Dorado, Augusta, Winfield, and Arkansas City are the principal communities within the study area. Major economic endeavors are agriculture, mining, and manufacturing industries. Petroleum refining is the most significant water-using manufacturing activity.

V. THE ECONOMY

Present

Employment [18-20]

The civilian labor force in the study area has increased from 25,366 to 28,953 between 1950 and 1960. This increase is accompanied by some marked changes in the makeup of the labor force. The most significant change in the employment pattern is a shift from employment in agriculture to employment in manufacturing. In 1950, agricultural employment accounted for 20.4 percent of the employment in the area. In 1960, agriculture accounted for only 10.1 percent of the employed. In contrast, the percent of employed in manufacturing increased from 15.9 percent in 1950 to 22.3 percent in 1960. This information is shown in table V-1. The total basic category includes all the commodity-producing industries (agriculture, forestry, fishing, mining, construction, and manufacturing). The total service employment includes all noncommodity-producing industries (wholesale and retail trade, government, and others).

Table V-1

Study Area Labor Force [19-20] - 1950 and 1960

	1950	Percent of Employed	1960	Percent of Employed
Civilian Labor Force	23,366		28,953	
Agriculture	5,023	20.4	2,813	10.1
Forestry & Fisheries	5		---	
Mining	1,234	5.0	1,438	5.2
Construction	1,626	6.6	1,651	5.9
Manufacturing	3,917	15.9	6,194	22.3
Total Basic	11,805	47.9	12,096	43.5
Total Service	10,852	52.1	15,683	56.5
Employed	22,657		27,779	
Unemployed	709		1,174	
Percent Unemployed	2.8		4.1	

Principal Industries

Agriculture [21-23]

The value of farm products sold has nearly doubled from 1944 to 1959. This increase in value of crops and livestock sold, coupled with a decrease in number of farms, acres of cropland harvested, and farm labor, indicates technological improvements associated with a higher productivity of agricultural labor. Agricultural statistics for the study area appear in table V-2.

Table V-2

Study Area Agricultural Production [22-23]
1944-1959

	1944	1949	1954	1959
Number of Farms	4,791	4,476	3,928	3,416
Acres of Cropland Harvested	516,160	471,914	465,758	466,430
Value of All Crops Sold*	4,304	8,140	9,383	11,461
Value of All Livestock & Livestock Products Sold*	14,862	18,987	16,567	25,729

*In 1,000's of 1954 dollars.

Mining [24-32]

Minerals extracted in the study area include petroleum, natural gas, sand and gravel, and stone. The value of minerals extracted was over $33 million (constant 1954 dollars) in 1960. Value of minerals produced from 1953 to 1960 appears in table V-3.

Table V-3

Value* of Study Area Mineral Production [25-32]
1953 through 1960

Year	Total	Year	Total
1953	32,419	1957	34,309
1954	38,216	1958	35,240
1955	38,518	1959	34,069
1956	36,240	1960	33,261

*Figures in 1,000's of 1954 dollars.

Manufacturing [33-36]

The value added by manufacturing increased from $13,218,000 in 1939 to $37,271,000 expressed in constant 1954 dollars. These data appear in table V-4. Employment in manufacturing increased from 3,917 in 1950 to 6,194 in 1960. Most of the manufacturing employment occurs in transportation equipment, food and kindred, and other nondurable goods which include petroleum refining. There are five petroleum refineries in the study area with a combined refining capacity of 129,600 barrels per day. [37]

Table V-4

Study Area Value* Added by Manufacturing [33-35]
1939-1958

1939	1947	1954	1958
13,218	35,625	32,758	37,271

*Figures in 1,000's of 1954 dollars.

Future

Agriculture presently plays a leading role in the study area's economy. Anticipations are that the current level of agricultural employment will continue with an accompanying increase in production of livestock products.

Extraction of petroleum and natural gas is expected to decrease slightly. A portion of the oilfields in the study area is currently employing secondary recovery practices. However, indications are that extraction can continue at slightly less than present production rates over the next 50 years.

Increased petroleum refining is projected for the study area. Present capacity of 129,600 barrels (of crude) per day is expected to nearly triple within the next 50 to 60 years. In addition, prospects for development of a petrochemicals industry in the study area are bright. Projected petrochemical output in this area is expected to average 5,000 tons per day by 2020.

NOTE!! HIGH QUALITY WATER WAS NOT INCLUDED

Population [18-20]

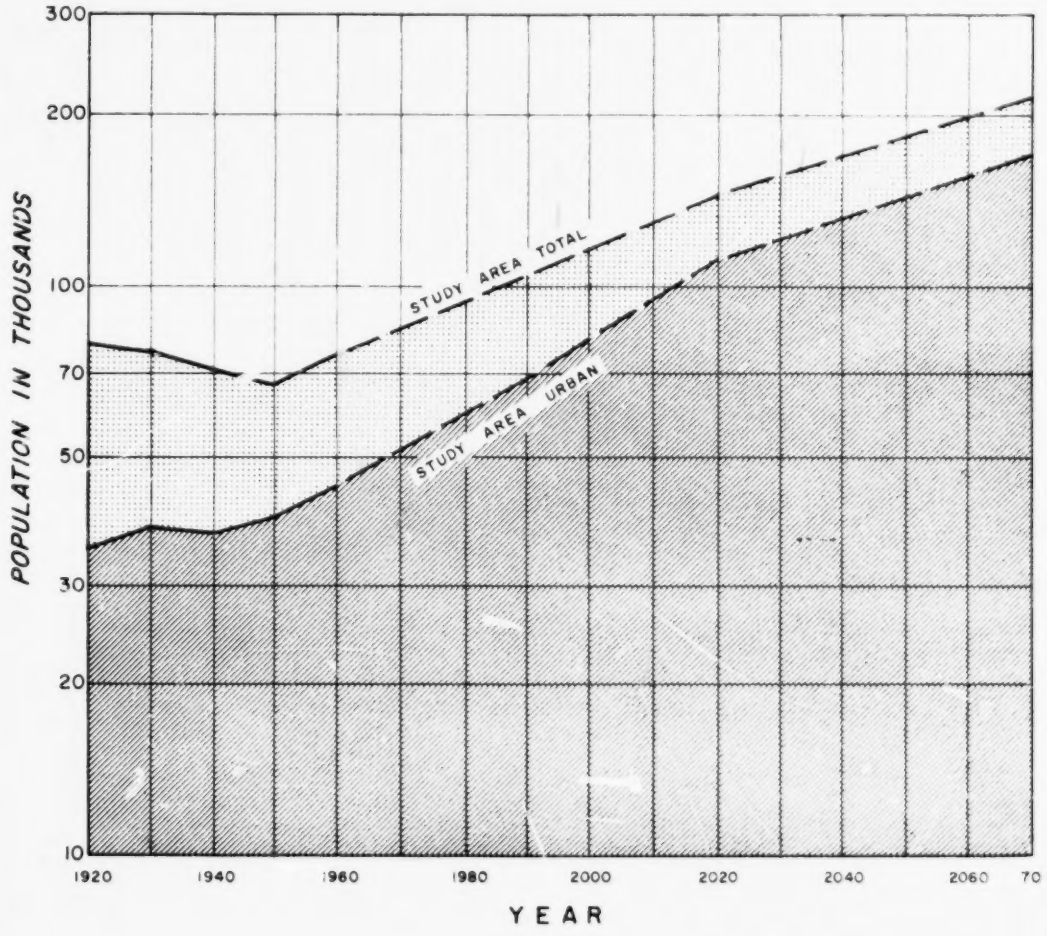
The population of the study area has increased 50 percent in the past 50 years. A significant part of this increase was registered in urban areas, which more than doubled in population between 1910 and 1960. The economic potential of the study area indicates a continuation of this trend.

Population projections for the study area are presented in table V-5. Study area population trends are illustrated in figure V-1.

Table V-5

Study Area 1960 and Projected 2020 and 2070 Populations

1960 [20/]		2020		2070	
Total	Urban	Total	Urban	Total	Urban
76,256	44,336	145,000	115,000	220,000	180,000



WATER RESOURCES STUDY
WALNUT RIVER BASIN – KANSAS

POPULATION TRENDS
AND PROJECTIONS

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE V-1

VI. WATER REQUIREMENTS

Municipal

Municipal water needs include residential, public, commercial, and those industrial requirements which are served by organized public water supply systems and are reflected in a per capita use figure. Included are distribution system losses, water used for backwashing filters together with other treatment plant losses, and evaporation from receiving reservoirs. Future municipal water needed is estimated by multiplying anticipated maximum annual per capita use by the projected study area population served by public water supply systems. The maximum annual per capita municipal need (for 2020) is expected to be 175 gallons per capita day (gpcd). Estimated 2020 total need for municipal water supplies is 20 mgd in the Walnut River basin (see table VI-1).

Industrial

Industrial water requirements are those significant quantities of water required in the manufacture of goods and the processing of materials more appropriately measured in use per unit(s) of production. The projections of total industrial water requirements are based on expected water use per unit of production (developed for this region by the Arkansas-Red River Basins Water Quality Conservation Project) amounting to 87 gallons per barrel of petroleum refined and 4,200 gallons per ton of raw petrochemical produced. Projected 2020 industrial water requirements of 55 mgd for the study area (shown in table VI-1) are based upon maximum recirculation and reuse of water.

Irrigation

Irrigation currently plays a minor role in the Walnut River basin, with approximately 300 acres (of the estimated 12,000 irrigable acres in the basin) receiving supplemental water when required during the growing season. Expectations are that acreage receiving supplemental surface water irrigation will increase to 3,400 acres by 2020, requiring 5,000 acre-feet per year (or an annual average of 4.5 mgd). Water for this use will be pumped from basin streams for application with no definable return flow to surface waters.

No reservoir storage is planned specifically for irrigation; however, flows are expected to be available for this use in the middle and lower reaches of the basin, except during drought. Increased flows would result from discharges of adequately treated wastes and water quality control releases.

Table VI-1

Water Requirements and Proposed Sources of Supply
Walnut River Basin, Kansas
2020 and 2070

Requirements	Quantity Acre-ft. Annually	Quantity Avg. mgd	Drought Recurrence Interval (Years)
2020 Needs			
Municipal	22,400	20	50
Industrial	61,500	55	50
Irrigation	5,000	4.5	50
Out-of-stream Needs	88,900	79.5	
Quality Control	16,400	14.6	20
2070 Total Needs	145,000	130	20

Sources of Supply	Quantity Acre-ft. Annually	Quantity Avg. mgd	Drought Recurrence Interval (Years)
2020			
Existing Sources:			
Lake Bluestem	1,680	1.5	50
Lake Augusta	1,120	1.0	50
Ground Water	10,000	9.0	50
Study Projects:			
El Dorado [a/]	17,000	15.2	50
Douglass	15,900	14.2	50
Towanda [b/]	2,200	2.0	50
Future Impoundments	11,200	10.0	50
Walnut River [c/] at Winfield	31,000	27.5	50
Supply for Out-of-stream Use	90,100	80.4	
Towanda	16,400	14.6	20
2070 Total	145,000 [d/]	130	20

a/ Initially, storage should be provided to yield 5,800 acre-feet annually (5.2 mgd) for quality control purposes and 12,300 acre-feet annually (11.0 mgd) for municipal and industrial purposes with statistical tolerances shown in table for these uses.

b/ To be blended with water from existing and project sources to provide water of quality suitable for general municipal and industrial use.

c/ Made up of adequately treated waste releases, quality control releases, and intervening area runoff to be blended with higher quality ground and future impoundment waters to provide water of quality suitable for general municipal and industrial use.

d/ Additional impoundments, together with technologic breakthrough in water quality preservation and acceptance of more frequent curtailment of water use, will permit a high order of water use and quality management to meet future needs.

Water Quality Control Requirements

Under the provisions of the Federal Water Pollution Control Act, Public Law 84-660, as amended by Public Law 87-88, consideration must be given to the inclusion of storage for regulation of streamflow to control water quality in any reservoir being planned by a Federal agency. Storage and release of this water are not to be provided as a substitute for adequate treatment of wastes at their sources.

Water quality analysis is based on broad parameters which are currently available for evaluation of future stream conditions. Total dissolved solids (TDS) is employed to characterize the effects of stable pollutants (those constituents which are not utilized or reduced by stream environment) such as chloride salts. Dissolved oxygen content is applied as a measure of unstable pollutants (those constituents which decay and act on, or are acted on by, the stream environment) as appraised by biochemical oxygen demand (BOD). Dissolved oxygen is a significant factor in maintenance of an environment proper for propagation of fish and aquatic life.

Determination of storage requirements for water quality control is based upon the effects of adequately treated waste releases, resulting from expected economic expansion and population growth, upon receiving stream regimen. The following criteria or conditions are assumed for estimating water quality control requirements: (1) removal of 90 percent of the organic substances exerting a biochemical oxygen demand (BOD) and no total dissolved solids (TDS) removal will be achieved by treatment; (2) treated wastes will be mixed uniformly in receiving waters; (3) dissolved oxygen content will be maintained at 4 parts per million (ppm) or more in the stream, and other chemical and physical characteristics will not exceed limits described in the Public Health Service Drinking Water Standards--1962 in treated water; and (4) storage and waste releases will, insofar as possible, be arranged to accomplish maximum use of the water resources in the basin.

Flow regulation requirements for water quality control are summarized in table VI-1, page VI-2.

2070 Water Requirements

Anticipated total average daily study area requirements for municipal and industrial water supply and water quality control purposes are 130 mgd, based on a projected total study area population of 220,000 in the year 2070.

Basin Plan to Maintain Water Quality

Flow regulation in the eastern Walnut River basin is currently required for quality control downstream from El Dorado. By providing 5,800 acre-feet annually (average 5.2 mgd) of flow regulation for quality control from the El Dorado project, the upper Walnut River from El Dorado to Augusta can be maintained at a suitable level of quality based on 13,980 acre-feet annual municipal and industrial use (12.5 mgd) from existing Lake Bluestem and storage at the El Dorado site. Average monthly regulation releases will vary from zero in December, January, and February to 1,700 acre-feet (18.5 mgd) in June, July, August, and September.

Increased use for municipal and industrial water supply purposes could be made of yield from storage at the proposed El Dorado site by transferring the release of adequately treated wastes from the El Dorado area (via a long outfall sewer) to a point downstream from the confluence of Whitewater River with the Walnut River and using water from storage at the proposed El Dorado site for municipal and industrial purposes only. Under these conditions of expanded municipal and industrial use in the El Dorado-Augusta area, 16,400 acre-feet annually (14.6 mgd) will be needed for flow regulation to maintain suitable water quality in the reach of the Walnut River downstream from the El Dorado-Augusta area in the year 2020.

While water to be stored in the proposed Towanda project is of unsuitable quality for general municipal and industrial use, its quality will be appropriate for controlling dissolved oxygen balance in the Walnut River basin as soon as available (1970).

Firm flow at Winfield will be 53,000 acre-feet annually (48 mgd average) resulting from releases of adequately treated waste from the El Dorado-Augusta area, quality control releases from the proposed Towanda Reservoir, and intervening area runoff. Of this amount, 31,000 acre-feet (27.5 mgd average) can be withdrawn and, when blended with high quality ground and locally impounded surface waters, will be suitable for municipal and industrial use in the Winfield-Arkansas City area. Adequately treated wastes from this area can be released to the Walnut and Arkansas Rivers.

VII. VALUE OF STORAGE FOR MUNICIPAL, INDUSTRIAL, AND WATER QUALITY CONTROL PURPOSES

Method of Evaluation

Senate Document No. 97 (87th Congress, 2d sess.) permits the following method of measuring benefits of storage in Federal reservoirs for municipal and industrial water supply:

> "The amount water users should be willing to pay for such improvements in lieu of foregoing them affords an appropriate measure of this value. In practice, however, the measure of the benefit will be approximated by the cost of achieving the same results by the most likely alternative means that would be utilized in the absence of the project."

This alternative cost method was used to evaluate both the municipal and industrial water storage and the storage for quality control.

Alternative Plans Considered

Several alternative plans could possibly be developed to serve expected water needs in the Walnut River basin. These include use of ground water and impoundment of tributaries other than those under consideration. Transbasin diversion from adjoining watersheds does not appear to hold much promise, since the Wichita area to the west holds prior claim to water in its basin; while to the east the upper Verdigris basin's plans are, for all practical purposes, committed and do not include diversion to the Walnut River basin. Based on findings of the Kansas Water Resources Board, sources of ground water in the study area yield neither sufficient quantity nor satisfactory quality to serve future needs. Impoundments on tributaries other than those being considered would either prove less economical to develop and provide transportation to the expected point of need or incapable of yielding the quantities and quality required for general use.

Following investigation of various possibilities, single-purpose reservoirs at the sites of the multipurpose projects were adopted as the most reasonable alternatives. A single-purpose impoundment having a yield equal to the yield of the storage to be provided for municipal, industrial, and/or quality control purposes in the proposed multipurpose project was assumed for each project site.

Based on the water supply and water quality control plan outline in table VI-1, annual tangible benefits attributable to the projects are as shown in table VII-1.

In addition to these tangible values, various intangible benefits can be attributed to the avoidance of adverse effects which would accrue in the absence of providing flow regulation for water quality control through use of these projects. Intangible benefits include the avoidance of: loss of economic activity due to unavailability of suitable quality water; downgrading of recreational opportunities along the main stem; damage to fish and aquatic biology; and degradation of the aesthetics of enjoyment of flowing surface waters.

Control of water quality by streamflow regulation, utilizing storage in the proposed Towanda project, will result in preservation of fish life and aquatic biology and provide water for municipal, industrial, and other legitimate uses throughout the middle and lower reaches of the Walnut River, while a similar use for yield from storage at the El Dorado site will benefit the upper reaches of Walnut River in addition to the middle and lower reaches. Benefits from storage for water quality control in these projects can be considered widely distributed.

Table VII-1

Summary of Benefits - Proposed Walnut River Basin Projects

Proposed Site	Yield From Storage Acre-ft. Annually	Yield From Storage Avg. mgd	Purpose of Storage	Year of First Need	1970 Worth Average Annual Benefit ($1,000)
El Dorado*	12,300	11.0	Municipal and Industrial	1970	374.0
	5,800	5.2	Quality Control	1970	144.6
Douglass	15,900	14.2	Municipal and Industrial	1970	341.8
Towanda	2,200	2.0	Municipal and Industrial	2010	21.5**
	16,400	14.6	Quality Control	1970	330.1

* Initially El Dorado Reservoir should yield the amounts shown for quality control and municipal and industrial use. The 2020 plan would require that adequately treated wastes from upper basin be released downstream from the Whitewater River. Municipal and industrial use would be 17,000 acre-feet per year (15.2 mgd) with an average annual benefit of $518,600 for this use.

**1970 value discounted from 2010 at 2 7/8 percent.

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